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PROPOSAL TO THE R.I.M. COMMITTEE

A RISK ANALYSIS PROCESS FOR EVALUATING AQUATIC NON-INDIGENOUS SPECIES

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CONTENTS

I. INTRODUCTION:

The purpose of this paper is to propose separate but interconnected processes to meet the risk analysis needs of the Aquatic Nuisance Species Task Force's committee on Risk Identification and Management(RIM).

These requirements are:

- HAZARD IDENTIFICATION -- Develop a set of criteria to help identify and prioritize pathways that present a risk for introducing non-indigenous aquatic organisms.

- RISK ASSESSMENT -- Develop a process that can be used to:
  a) evaluate recently established non-indigenous organisms
  b) evaluate non-indigenous organisms proposed for deliberate introduction
  c) evaluate the risk associated with individual pathways

- RISK MANAGEMENT -- Develop a practical operational approach to maximize a balance between protection and the available resources for:
  a) reducing the probability of unintentional introductions
  b) reducing the risk associated with intentional introductions

The basic goal will be to develop a process (a paradigm) that will help identify and focus on those pathways and organisms found to present the highest risk and determine if mitigation is feasible or wanted.

Because of the complexity of issues that the RIM must cover, this document will not address which methodologies are best to use on specific problems or compare various methodologies for usefulness (i.e. Risk versus benefit analysis, Bayes versus Classical Statistics, Quantitative versus Qualitative approaches, Probability Theory versus Scientific Judgement).

Which methodologies will be useful, and in which cases, will depend upon the resources available, the amount of data associated with the pathway or organism, and the applicability of methodologies available at the time of the assessment. RIM's goal is to produce a process which provides the assessor with the freedom to use a variety of methods to determine the degree of risk.

II. HAZARD IDENTIFICATION:

An Enhanced Hazard Identification process is approached by first developing a set of criteria by which to evaluate the suspected hazards. The hazard may be defined as; exotic organisms which have the potential to cause economic or environmental damage if established in North American aquatic ecosystems. An example of an Enhanced Hazard Identification of a pathway evaluating non-indigenous organisms is the *Pest Assessment of Australian Riverland Citrus* (Orr, 1992).

The Enhanced Hazard Identification process will determine the *relative risk* of the pathways evaluated, not the *absolute risk*. In other words the process can determine if pathway "X" is more risky than pathway "Y"; but it cannot determine the absolute risk of any of the pathways. For example, the Enhanced Hazard Identification process will not be able to predict the number of exotic organisms that would become established due to the pathway or the amount of economic or environmental damage if they do so..

It is important to realize that the goal of the hazard identification is to identify those pathways presenting the highest risk. Trying to determine absolute risk of a pathway at this stage of the assessment would be counter productive. The reason for this is because of the resources required and the high degree of biological uncertainty associated with most non-indigenous aquatic organisms.

Determining what the criteria are going to be and what options they consist of have not yet been determined. Appendix I contains a set of possible criteria and an example of how the process could be set up. Appendix I is designed to illustrate the process and therefore the criteria and options used are subject to change by the RIM committee.

It may very well be that different sets of criteria may need to be developed by the RIM committee to be relevant for evaluating different "types" of pathways (i.e. pet industry introductions, aquaculture importations, ships ballast, etc.). Even if the RIM committee agrees to the enhanced hazard identification process and the associated criteria, the determination of the individual pathways would still need to be completed by scientists most familiar with the organisms of concern. This final step would be beyond the scope of the RIM committee.

III. RISK ASSESSMENT:

The Generic Non-Indigenous Pest Risk Assessment Process (hereafter referred to as the Generic Process) will be used for estimating the risk of introducing exotic aquatic organisms into North America. Modifications of the Generic Process will be used to:

a) evaluate recently established non-indigenous organisms
b) evaluate non-indigenous organisms proposed for deliberate introduction
c) evaluate the risk of individual pathways

The Generic Process was developed so that it can evaluate the risk of non-indigenous organisms associated with a specific import commodity or pathway; or evaluate specific predetermined species of concern such as recently established exotic species or deliberate introductions. One of the main purposes of the Generic Process is to provide a framework where scientific information could be organized into a format that could be understood and useful to managers and policy makers.

The following quality criteria were used to ensure that the design of the Generic Process met the above goals.

- Comprehensive - The assessment should review the subject in detail and identify sources of uncertainty in data extrapolation and measurement errors. The assessment should evaluate the quality of its own conclusions. The assessment should be flexible to accommodate new information.

- Logically Sound - The risk assessment should be up-to-date and rational, reliable, justifiable, unbiased, and sensitive to different aspects of the problem.

- Practical - A risk assessment should be commensurate with the available resources.

- Conducive to Learning - The risk assessment should have a broad enough scope to have carry-over value for similar assessments.

- Open to Evaluation - The risk assessment should be recorded in sufficient detail and be transparent enough in its approach that it can be reviewed and challenged by qualified independent reviewers.

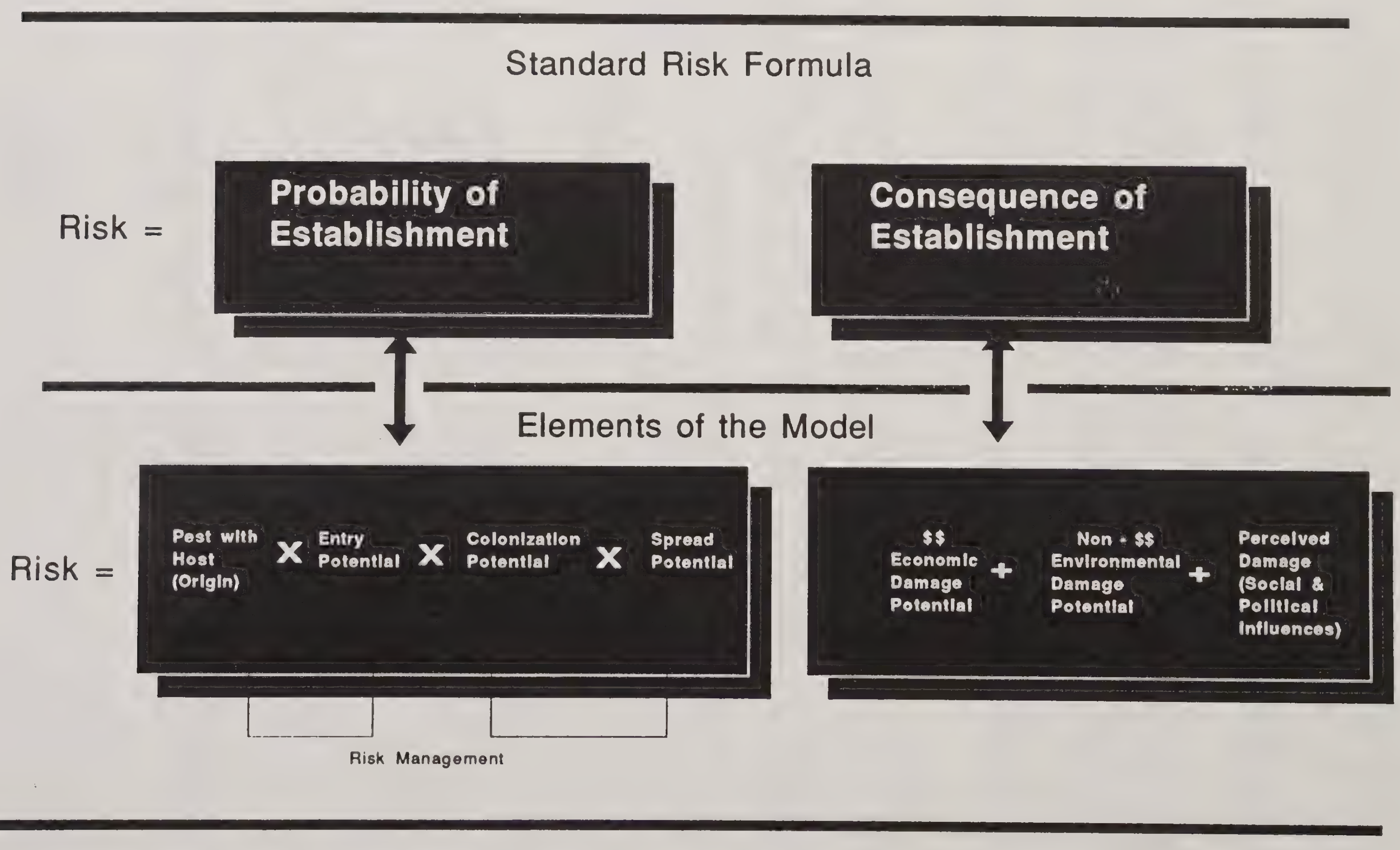
The Generic Process has demonstrated its ability to evaluate non-indigenous organisms. A list of assessments completed using the Generic Process can be found in Appendix II.

Although, it is beyond the scope of this proposal to describe the Generic Process in detail Appendix III provides an example of a completed assessment (Cherry Bark Tortrix). Details of the Generic Process can be found in Orr and Cohen, 1991.

In summary the Generic Process uses a "*Pest Risk Assessment Model*" (figure 1) to guide the evaluation of an exotic organism

FIGURE 1

Pest Risk Assessment Model



- For model simplification the various elements are depicted as being independent of one another
- The order of the elements in the model does not necessarily reflect the order of calculation.

of concern. The Pest Risk Assessment Model is divided into two major components the "probability of establishment" and the "consequence of establishment". This division reflects how a regulatory agency would evaluate an exotic organism (e.g. more resources are used to lower the probability of a particular exotic pest establishing -- if the consequences of its establishment are greater).

The two major components of the Pest Risk Assessment Model are further divided into 7 basic elements which serve to focus biological information into the assessment.

It is important to recognize that the Pest Risk Assessment Model is a working model and represents a simplified version of the real world. In reality the specific elements of the Pest Risk Model are not static or constant, but are truly dynamic showing distinct temporal and spatial relationships. In addition, the elements do not carry equal value in weighing the risk. The weight of the various elements will never be static because they are strongly dependant upon the specific exotic organism being evaluated and the characteristics of the environment at the time of the organism's introduction.

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The characteristics and explanations of the seven elements of the Pest Risk Assessment Model are as follows:

Elements -- Group 1: Assess Probability of Pest Establishment

1. <u>Pest with Host (Origin)</u> -- Estimate probability of the organism of concern being on, with, or in the pathway.

The major characteristic of this element is: Does the organism show a convincing temporal and spatial association with the pathway.

2. <u>Entry Potential</u> -- Estimate probability of the organism surviving in transit.

Some of the characteristics of this element include: The organisms hitchhiking ability in commerce, ability to survive during transit, stage of life cycle during transit, and number of individuals expected to be present in the pathway.

3. <u>Colonization Potential</u> -- Estimate probability of organism colonizing and maintaining a population where introduced.

Some of the characteristics of this element include: The organism coming in contact with an adequate food resource, encountering appreciable environmental resistance, and ability to reproduce in the new environment.

4. <u>Spread Potential</u> -- Estimate probability of the organism to spread beyond the colonized area.

Some of the characteristics of this element include: Ability for natural dispersal, ability to use human activity for dispersal, ability to readily develop races or strains, and the estimated range of probable spread.

Elements -- Group II: Assess Consequence of Establishment

5. <u>Economic Damage Potential</u> -- Estimate economic impact if established.

Some of the characteristics of this element include: Economic importance of hosts, aquaculture loss, effects to subsidiary industries, exports, control costs, and efficacy.

6. <u>Environmental Damage Potential</u> -- Estimate environmental impact if established.

Some of the characteristics of this element include: Ecosystem destabilization, reduction in biodiversity, reduction or elimination of keystone species, reduction or elimination of endangered/threatened species, and the effects of control measures.

7. <u>Perceived Damage (Social & Political Influences)</u> -- Estimate impact from social and/or political influences.

Some of the characteristics of this element include: Aesthetic impacts, consumer concerns, and political repercussions.

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Although no attempt has been made to present all of the details of the Generic Process in this proposal, it is important to emphasize that each exotic organism is unique. The assessor needs to have the freedom to modify the model and process to best represent the risk of a particular organism. The seven elements need to be retained to calculate the risk but other sections may be added or subtracted without concern. If the assessor feels that information, ideas, or recommendations would be useful, they should be included in the assessment. The assessor can combine "like" pests into a single assessment if the biology permits (e.g. tropical aquarium fish destined to temperate North America).

The source of the biological statements and the degree of uncertainty the assessor feels is associated with each element rating would be recorded.

IV. RISK MANAGEMENT:

Risk management involves two steps:

- Step 1: Matching the available mitigation options with the identified risks and;
- Step 2: Developing a realistic operational approach to maximize a balance between protection and resources.

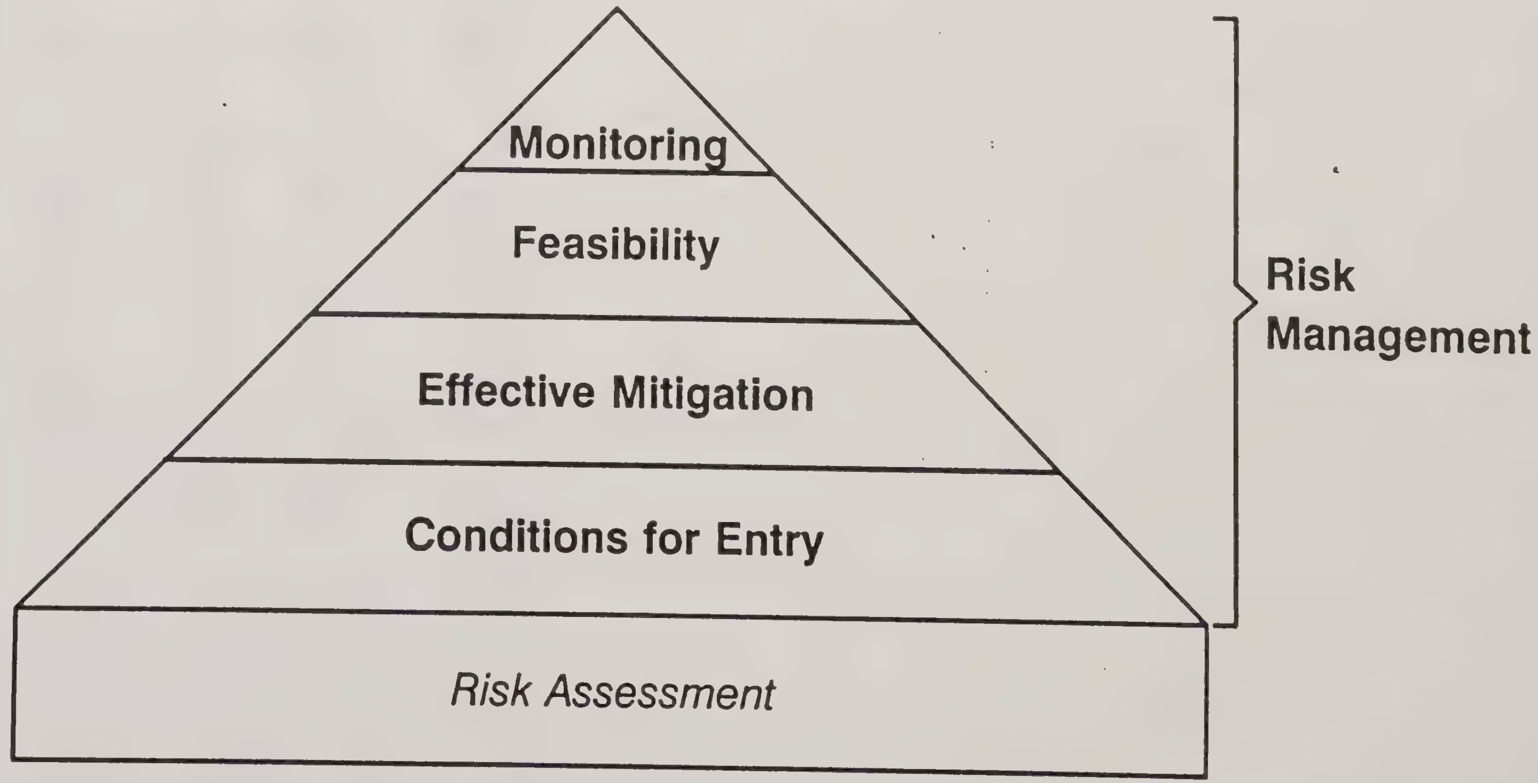
STEP 1: Matching the available mitigation options with the identified risks is easily done by creating a mitigation matrix placing the organisms (or groups of organisms) identified in a specific pathway along one axis and the available mitigation options along the other. Where a specific organism (or group of organisms) meets a specific mitigation process in the matrix, the efficacy for control is recorded. Using this process it becomes apparent which mitigation or mitigations are needed to reduce the risk to an acceptable level. An example is the mitigation matrix shown in Appendix IV (USDA, APHIS, 1991) which addresses the pest organisms identified in the Siberian Log Risk Assessment (USDA, FS, 1991).

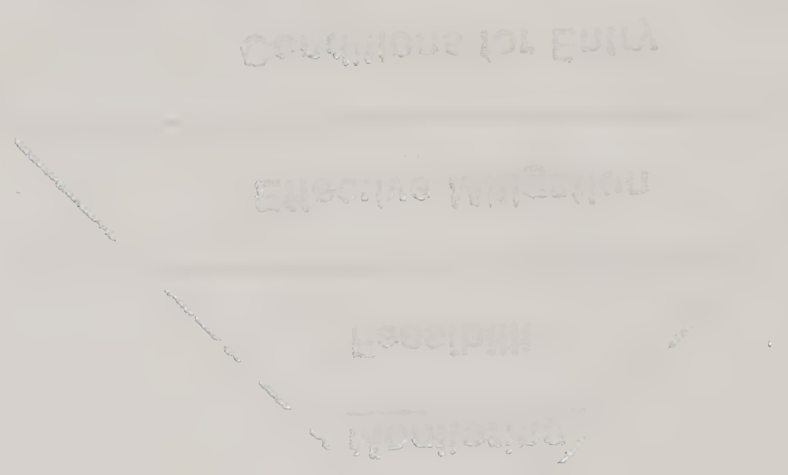
STEP 2: Developing a realistic operational approach is more difficult. Each new operational decision will have to take into consideration a number of management, agency, and biological factors which will always be unique to any specific exotic organism or pathway. However, at an operational risk management level, each one of the steps in Figure 2 is a process that needs to be examined before approval of the importation, or action against an exotic organism or pathway is taken.

The steps in Figure 2 include the risk assessment, the development of conditions for entry to meet current regulatory requirements, effective mitigation of pests in the risk assessment if any are identified, feasibility of the importers to meet the requirements, and finally, a system of monitoring to insure that all regulatory requirements are maintained.

FIGURE 2

Building Systems for Safe Importations




Conditions for Entry
Feasibility

V. REFERENCES:

Orr and Cohen, 1991. Generic Pest Risk Assessment Process (Generic Process). USDA APHIS PPD unpublished draft.

Orr R.L., 1992. Pest Assessment on Australian Riverland Citrus. USDA, APHIS, PPD risk assessment, 38 pages.

USDA, APHIS, 1991. An Efficacy Review of Control Measures for Potential Pests of Imported Soviet Timber. Miscellaneous Publication No. 1496.

USDA, FS, 1991. Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East. Miscellaneous Publication No. 1495.

USDA, FS, 1992. Pest Risk Assessment of the Importation of Pinus radiata and Douglas-fir Logs from New Zealand. Miscellaneous Publication No. 1508.

USDA, FS, 1993. Pest Risk Assessment of the Importation of Pinus radiata, Nothofagus dombeyi and Laurelia philippiana Logs from Chile. Miscellaneous Publication No:(in press).

APPENDIX I

A PROPOSED ENHANCED HAZARD IDENTIFICATION PROCESS

This appendix will describe the Enhanced Hazard Identification process in more detail. The criteria and example organisms used are for demonstration only and may not reflect the final criteria chosen by the RIM committee.

Three hypothetical test pathways will be used to work through the process. Each pathway will be assigned one of the options for each of the three criteria, so that each pathway will have one option from each of the three criteria. The three assigned options will form a "Risk Category" for the pathway. The Risk Category is then used to compare the relative risk of the three pathways in relation to each other by using Table II.

In an actual assessment using this process, the scientific references used in determining the risk rating would be recorded along with the risk rating. An example of how this process works can be found in the "Pest Assessment on Australian Riverland Citrus" (Orr, 1992). However, in this hypothetical example references are not used.

Table II contains, in descending order of risk, all possible combinations of the options listed (Risk Categories), along with the relative risk ratings. By comparing the "Risk Category" assigned to a specific pathway one can (using Table II) compare its relative risk to any other identified pathway which has also been assigned a Risk Category.

Three example pathways were chosen to demonstrate the process. They are:

- Example 1: Movement of exotic temperate fresh water clams into the United States for aquaculture farming.
- Example 2: Ballast water in sea going vessels.
- Example 3: Movement of exotic tropical salt water aquarium fish into Canada.

Step 1: Calculating the Risk Category:

Starting with the first example:

"Movement of exotic temperate fresh water clams into the United States for aquaculture farming",

Review the available sources for information and (using Table 1) determine which option for each of the three criteria best fits this pathway. The Risk Category is the combination of the three options. For the movement of exotic fresh water clams the Risk Category is (M)(M)(P).

Each option has an assigned "Relative Risk Rating" which will reflect the belief of the assessor(s) concerning the relative rating this option has in relationship to the risk represented by the other options. The assessor can either add the three Relative Risk Ratings picked for the Risk Category for example 1;

$$(M=3)+(M=3)+(P=3) = 9$$

or use Table 2 and find where the Risk Category is listed and check the Relative # Rating column to obtain the same answer.

This process would be repeated for example 2 and example 3 so that each has been assigned a Risk Category.

Example 1 (clams/aquaculture)	= (M)(M)(P)	=	9
Example 2 (ballast water)	= (H)(H)(P)	=	11
Example 3 (marine aquarium fish)	= (L)(L)(A)	=	5

Step 2: Ranking the Organisms based on the Risk Category: Using Table II, one can now rank these three pathways numerically or verbally to represent the relative risk.

Example 2 (ballast water)	=	11	= Extreme High
Example 1 (clams/aquaculture)	=	9	= High
Example 3 (marine aquarium fish)	=	5	= Very Low

TABLE 1: KEY TO THE CRITERIA USED TO EVALUATE THE RISK OF SPECIFIC PATHWAYS TO INTRODUCE NON-INDIGENOUS PEST ORGANISMS

Criterion 1: What is the potential of establishment (including escape) and spread of the "types" of non-indigenous pest organisms associated with the pathway?

Options for Criterion 1:

(H) High probability of establishment and spread based on demonstrable evidence. RELATIVE RISK RATING = 4

(M) Moderate probability of establishment and spread based on demonstrable evidence. RELATIVE RISK RATING = 3

(L) Low probability of establishment and spread based on demonstrable evidence. RELATIVE RISK RATING = 2

(Z) Nearly (z)ero probability to establish or spread RELATIVE RISK RATING = 1

Biological characteristics which may be important for deciding the correct option for criterion 1 would be listed to help guide the assessors.

Criterion 2: What is the damage potential of the "types" of organisms associated with the pathway?

Options for Criterion 2:

(H) High (demonstrable) potential for environmental and/or economic damage RELATIVE RISK RATING = 4

(M) Moderate (demonstrable) potential for environmental and/or economic damage RELATIVE RISK RATING = 3

(L) Low potential for environmental and/or economic damage RELATIVE RISK RATING = 2

Biological characteristics which may be important for deciding the correct option for criterion 2 would be listed to help guide the assessors.

Criterion 3: What historical evidence is there that this pathway or similar pathways have been associated with the movement of non-indigenous pest organisms?

<u>Options for Criterion 3:</u>

(P) Two or more historical examples exist where non-indigenous (p)est organisms have been introduced by this pathway
RELATIVE RISK RATING = 3

(E) Based on (e)xtrapolation from existing evidence of other pathway reviews, this pathway has the potential for the movement of non-indigenous pest organisms; and/or one historical example exists where a non-indigenous pest organism was introduced.
RELATIVE RISK RATING = 2

(A) Historical evidence is (a)bsent that would tie this pathway with the introduction of non-indigenous pest organisms.
RELATIVE RISK RATING = 1

Biological or historical characteristics which may be important for deciding the correct option for criterion 3 would be listed to help guide the assessors.

TABLE II. Risk Categories by Descending Risk

RISK CATEGORY	VERBAL RATING	RELATIVE # RATING
(H)(H)(P)	extreme high	11
(H)(H)(E)	very high	10
(H)(M)(P)	very high	10
(M)(H)(P)	very high	10
(H)(H)(A)	high	9
(H)(M)(E)	high	9
(M)(H)(E)	high	9
(M)(M)(P)	high	9
(L)(H)(P)	high	9
(H)(L)(P)	high	9
(H)(M)(A)	medium to high	8
(H)(L)(E)	medium to high	8
(M)(H)(A)	medium to high	8
(M)(M)(E)	medium to high	8
(M)(L)(P)	medium to high	8
(L)(H)(E)	medium to high	8
(L)(M)(P)	medium to high	8
(Z)(H)(P)	medium to high	8
(H)(L)(A)	medium to low	7
(M)(M)(A)	medium to low	7
(M)(L)(E)	medium to low	7
(L)(H)(A)	medium to low	7
(L)(M)(E)	medium to low	7
(L)(L)(P)	medium to low	7
(Z)(H)(E)	medium to low	7
(Z)(M)(P)	medium to low	7
(Z)(L)(P)	low	6
(M)(L)(A)	low	6
(L)(M)(A)	low	6
(L)(L)(E)	low	6
(Z)(H)(A)	low	6
(Z)(H)(A)	low	6
(L)(L)(A)	very low	5
(Z)(M)(E)	very low	5
(Z)(L)(E)	very low	5
(Z)(L)(A)	extreme low	4

APPENDIX II: Examples of Risk Assessments using the Generic Process for Evaluating Non-indigenous organisms

I. COMMODITY ASSESSMENTS:

USDA FOREST SERVICE. 1991. Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East. Miscellaneous Publication No. 1495

USDA FOREST SERVICE. 1992. Pest Risk Assessment of the Importation of Pinus radiata and Douglas-fir Logs from New Zealand. Miscellaneous Publication No. 1508

USDA FOREST SERVICE. 1993. Pest Risk Assessment of the Importation of Pinus radiata, Nothofagus dombeyi and Laurelia philippiana Logs from Chile. Miscellaneous Publication No. 1517

II. SPECIFIC ORGANISM ASSESSMENT:

Lehtonen, P. 1993. Pest Risk Assessment on Chinese Water Spinach. USDA APHIS PPQ risk assessment, pp 22.

Huettel, R.L., Griffin, R.L., Caplen, R.T. 1993. Pest Risk Analysis for Pea Cyst Nematode. USDA APHIS PPQ risk assessment, pp 15.

Orr, R.L. and Cohen, S. 1991. Pest Risk Assessment on Potato Virus Y-N. APHIS PPD risk assessment, pp 14.

Orr, R.L. 1991a. Pest Risk Assessment on Apple Ermine Moth. USDA APHIS PPQ risk assessment, pp 15.

Orr, R.L. 1991b. Pest Risk Assessment on Cherry Bark Tortrix. USDA APHIS PPQ risk assessment, pp 13.

Schall, R.A. 1991. Pest Risk Assessment on Karnal Bunt. USDA APHIS PO risk assessment, pp 14.

Schall, R.A. 1992. Pest Risk Assessment on Larch-Poplar Rust. USDA APHIS PO risk assessment, pp 17.

APPENDIX III: Pest Risk Assessment on Cherry Bark Tortrix

The Cherry Bark Tortrix is an example of an assessment which was completed on a recently introduced exotic organism in order to determine what actions, if any, should be taken.

PEST RISK ASSESSMENT
ON CHERRY BARK TORTRIX (CBT)

PEST Enarmonia formosana (Scopoli)

FILE NO. 4

DATE December 23, 1991

PLANT Rosaceae trees with emphasis on domestic cherry and apple

ORIGIN British Columbia, Canada and Washington State, USA

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FINAL REVIEWERS

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Eric LaGasa, Entomologist, Washington State Dept. of Agriculture
Ron Milberg, OS - PPQ, United States Department of Agriculture

CONTENTS:

I. SUMMARY OF DISTRIBUTION, HOSTS, AND LIFE CYCLE:

Distribution: The Cherry Bark Tortrix (CBT) is a tortricid moth naturally distributed throughout Eurasia in broad-leaved and mixed forests with relatively high humidity, adequate host plants, and freezing winter temperatures. It is also found in Africa (Algeria) and North America (British Columbia, Canada and Washington State, USA)(G).

In Canada the population density is highest in Vancouver (Bell, 1991) making it the most likely location of introduction (J). The infestation extends from Vancouver to just northeast of Hope, British Columbia. Cherry Bark Tortrix is also established on Vancouver Island from Victoria to approximately 50 miles north of Nanaimo (Bell, 1991).

Seven Western Washington Counties, all of which encompass the Puget Sound region, are infested. The highest population levels were in those counties nearest the Canadian border, decreasing in counties to the south (LaGasa, 1991).

HOSTS: The CBT is recorded in Eurasia to have a marked preference for species of Prunus but often attacks a variety of other Rosaceous trees including Cydonia (Quince), Malus (Apple), Pyracantha (Firethorn), Pyrus (Pear), and Sorbus (Mountain-ash) (Garland, 1990). In Germany, the CBT is becoming increasingly important as a pest in peach, cherry, and apple (Schumann et al, 1974) (Dickler, 1970).

The CBT in the Pacific Northwest has been found infesting mature flowering (most) and fruiting (fewer) cherry trees. Introduced apple trees are, to date, also found occasionally infested but never to the extent as cherries.

Native species of Prunus, including the wide spread P. virginiana, have been found infested (LaGasa, 1991). However, no survey or study has yet focused on the moth's impact or selectivity to native species. The moth's present or future impact on indigenous species is unknown.

Life Cycle: The life cycle presented below is of the Eurasian population of CBT. This probably reflects, to a reasonable degree the life history of the Pacific Northwest population.

The adult moths first appear from the end of April to the beginning of May. The adult emergence period is long (from 3 to 4 months) and ends in September (Winfield, 1964). The adult has a wing span of 15-18 mm with the forewings brown with a purplish sheen marked with yellowish-orange irregular bands and a light-colored fringe (Dang and Parker, 1990).

The adults are crepuscular, being most active in the early morning (Dickler, 1972). The adults can be found during the day resting on the tree trunks where they are hard to see (Bradley, 1979). They are also attracted to artificial lights (G).

Females start to oviposit four to six days after emergence usually on the trunk and larger limbs of mature trees (G). The majority of sites are 0-290 cm from the ground (Dickler, 1970). Oviposition usually takes place in the early morning. A single female can lay 40 to 60 eggs. The eggs are most often laid singly but it is not uncommon to have 2 or 3 overlapping eggs together. Eggs are normally laid in crevices in the bark primarily near or at tree wounds or sites of previous infestations (Dickler, 1970).

The eggs are cream-white and lenticular in shape, becoming clear red after a few days. The red coloration later becomes restricted to a semicircle (Bradley, 1979). The eggs hatch in 14 to 24 days (G).

The larvae burrow in the bark and sapwood, and show a distinct preference for scar tissue. The first instar larvae burrow in all directions within the outer sapwood, while the 2nd through 5th instar larvae tunnel between the bark and the cambium. The wood behind the cambium is not attacked. The 3rd to 5th instar larvae overwinter by hibernation initiated by negative centigrade temperatures. Hibernation lasts around 5 months, with the larvae usually resuming activity in March. Those larvae that were mature at the time of hibernation, pupate soon after becoming active, while younger larvae resume feeding (G).

The mature larvae are 8-11 mm long and variable in color from brown to pink with brown pinacula. These mature larva tunnel toward the surface of the bark and spin a silken cocoon for pupation. The light brown pupa is 7 to 9 mm in length. The cocoon is located in the silk tube through which the larva last excreted its waste. The cocoon contains numerous frass particles within the silk. The cocoon usually protrudes from the bark surface. The pupa stage lasts approximately 15 days. There is one generation per year (G).

Information on the life cycle of the Pacific Northwest population is scant. The adults, like their European counterparts, exhibit long flight periods; May to at least September (LaGasa, 1991).

II. EPIDEMIOLOGY:

The larval habitat of preference is old wounds in mature trees. Eggs are laid near old or new wounds and the hatching larvae enter the tree. In addition to possibly providing an entrance, the developed or developing scar tissue might also be the food of choice. Infestations usually progress upwards on the tree with new healthy tissue becoming damaged at the edge of the scar tissue.

Under normal conditions in Eurasia this tortricid is not a major pest of fruit trees and becomes locally important only on mature trees when coupled with other woodborers, frost damage, excessive pruning and/or other sources which damage or stress the tree (Winfield, 1964) (Hobaus, 1982) (Boldyrev and Dobroserdov, 1980). Many European countries do not even list CBT as a pest. However, an example of CBT becoming a major pest problem was demonstrated in the outbreak which occurred in Germany in the 1970s where extensive damage occurred (See Dickler, 1970 and Schumann et al, 1974).

The larvae of CBT causes three main types of damage to the trees; 1) direct damage by larval feeding between the bark and the cambium, resulting in emission of gum, formation of wound tumors and die back of shoots; 2) indirect damage due to the attractiveness of the weakened and wounded trees to secondary pests such as Scolytids and fungi (<u>Valsa</u> spp. and <u>Stereum purpureum</u> are reported in Germany), and 3) indirect damage through increased susceptibility of damaged trees to frost and other unfavorable weather conditions because of their split and peeling bark (Dicker, 1972).

Frost damage or sun-scorch strongly influences the amount of damage the moth can inflict on the trees (Dobroserdov, 1981). The CBT is a fairly cold hardy insect with the temperature threshold for larval activity between 7 and 8 degrees centigrade (Sermann and Zahn, 1986). A repeating annual cycle of freezing damage, followed by a CBT infestation leading to a larger more exposed area of the tree susceptible to the next winter's freeze can, in a couple of years, kill a mature tree (Dickler, 1972). Younger trees, in general, appear to be physiologically better adapted keeping the moth from becoming established or, in some other way, tolerating or reducing the impact of CBT.

Because of the epidemiology of this insect, it is reasonable to speculate that normally the host trees have chemical defenses which inhibit, kill, or repel CBT. The moth can only do well in those trees, or parts of a tree, in which the chemical defenses are weak. This can be due to reduction of the chemical defenses because of the age of the tree, the inability of scar or wound tissue to produce the chemical(s) and when trees are under extreme stress (E).

The Pacific Northwest, where the CBT has been found, has had unusually severe winters and dry summers from 1989 to 1991. Cherry trees are greatly stressed throughout the region due to the harsh weather and the continued defoliation caused by the Winter Moth (LaGasa, 1991). It is difficult to separate the degree of damage caused by the CBT in these trees in relationship to the other stresses. It is important to recognize that cherry trees, outside of the CBT infested area, are also under great stress and in various states of decline.

It is also difficult to determine if the CBT is a recent introduction to North America and quickly spreading or, because of the opportunistic time and environment, the generally low moth population has increased to a detectable level. Entomologists working with the CBT in both Canada and Washington State believe that the introduction of CBT is not relatively recent and that the spread is through natural dispersion (LaGasa, 1991) (Bell, 1991).

The trapping and visual survey results in both Washington and British Columbia seem to support the hypotheses that the insect is spreading slowly by natural means and being maintained by mature, stressed, domestic, cherry trees (E,J). Based on Old World literature, it is reasonable to assume that as the population increases and spreads to other areas of the United States, that its food preferences within the Rosaceae might shift.

III. HISTORY OF DOMESTIC INTRODUCTION:

"In May 1989, at the request of a homeowner in Richmond, B. C., Agriculture Canada inspectors were asked to look at some cherry trees exhibiting symptoms of yellowing foliage and bark damage that included cankers, gumosis and frass. Larval and adult specimens were collected from the site...Other specimens were submitted from cherry trees exhibiting similar symptoms in Surrey and Vancouver... It is believed that E. formosana has been in the Richmond area for some time, judging from the size of lesions on the host trees caused by repeated infestations of larvae, and from the large number of adults caught in pheromone traps set in these areas during the summer of 1990." (Dang and Parker, 1990).

On February 21, 1991, the first specimens of CBT in the United States were collected from an ornamental cherry tree in the Peace Arch Park on the U.S./Canada border in Blaine, Whatcom County, Washington. The specimens were collected from a mature tree over 50 years of age. Infestation was near the original graft site (LaGasa, 1991).

IV. RATING ELEMENTS:

PROBABILITY OF ESTABLISHMENT

Estimate probability of pest to spread beyond the colonized area. HIGH (RC)

Although the probability to spread is evaluated as high, it is difficult to determine the speed in which it will do so. This is because only a couple of years of data is available and the date of the initial introduction of CBT is unknown. In Hungary, the CBT is reported to fly out of infested orchards only in limited numbers

(Sziraki, 1984) and have low dispersal tendencies (Sziraki, 1982). In the United States, outside of beginning to delineate the infestation, little information has been gathered. The best that can be done is based on the apparent CBT population density gathered by the trapping and visual survey results in both Washington and British Columbia. This seems to indicate that the insect is spreading slowly by natural means (E,J).

Spread by human activity such as firewood, movement of nursery stock, etc. does not appear to be occurring at this time in the Pacific Northwest (LaGasa, 1991) (Bell, 1991) (J).

CONSEQUENCE OF ESTABLISHMENT

Estimate economic impact if established. **MODERATE (RU)**

COMMERCIAL ORCHARDS: (Note -- no commercial orchards have been infested in North America, however extensive surveys have not been conducted -- cherry and apple orchards occur within the North American infestation)

There is little doubt that if CBT is left unchecked for many years that the productive life of an infested orchard [e.g. cherry] will be shortened (Winfield, 1964). Chemical control against the eggs and adults is not practical because of the extended period of adult activity. Chemical controls against the larvae are not part of the present IPM programs in North America (G).

"It seems unlikely that a treatment for cherry-bark tortrix moth could be included in a normal orchard-spray program " (Winfield, 1964).

Old-established orchards which are past their peak of production will be the hardest hit by CBT (Winfield, 1964). The trunk and larger limbs of trees will be the areas most likely affected by CBT, especially at wounds (both natural and pruning) and grafting sites.

An outbreak of CBT in Germany caused damage to young cherry trees in their fifth year of orchard growth. The young trees that suffered the most were in orchards without soil cultivation or where a mulching system was in use (Dickler, 1970).

Keeping the bases of trees free from grass and weeds appears to be very helpful in Europe for maintaining the pest under the economic threshold (Hobaus, 1982) (Dickler, 1972). Using cold resistant varieties of trees to reduce the effects of CBT has been recommended (Dobroserdov, S.G. 1981).

<u>ORNAMENTAL TREES:</u> (Note -- ornamental and fruiting cherry and apple trees have been found infested)

Mature ornamental flowering and fruiting cherry trees constitute the major impact of the North American population of CBT at this time. In some locations nearly 100% of the trees are infested. Many of these trees are so heavily infested that it is obviously contributing to the excessive stress and/or death of the trees (LaGasa, 1991) (Bell, 1991).

At present, there are no insecticides registered in North America specifically for this insect.

<u>NURSERY STOCK:</u> (Note -- no nursery stock has been found infested in North America. Nursery stock does occur within the North American infestation.)

In Europe, greenhouse nursery stock have been attacked at graft sites and stem tips, when repeated pruning caused excessive bark formation. Larval damage caused excessive gum formation and less shoot growth, which often resulted in the death of the tree or rootstock (Minks et al, 1976). This practice was conducted in a greenhouse environment. Similar practices do not occur in the Pacific Northwest nurseries (G).

In the Pacific Northwest, nursery stock grown in CBT areas do not show any infestation. Nine different nursery sites were examined for CBT in Washington State in 1991. Eleven-thousand, one-hundred, ninety-seven trees, consisting of the genera <u>Sorbus</u>, <u>Pyrus</u>, <u>Malus</u>, and <u>Prunus</u> were examined. Other genera belonging to the rosaceae were also examined. Inspection focused on the trunk of the trees from the base to eye level into the canopy. Emphasis was placed on, but not limited to, grafted areas, pruning wounds, and other damaged areas. Some of the nurseries were located in areas where mature cherry trees were heavily infested. No CBT was found in the nursery stock (Wraspir, 1991) (LaGasa, 1991).

To date, no nursery stock has been found infected with CBT in either Canada or the United States, even though visual signs due to larval damage would be evident. (LaGasa, 1991)

Estimate environmental impact if established. **<u>MODERATE (VU)</u>**

Native species of <u>Prunus</u>, including the wide spread <u>P</u>. <u>virginiana</u>, have been found infested (LaGasa, 1991). However, no survey or study has yet focused on the moth's impact or selectivity to native species. The moth's present impact on indigenous species is unknown.

The genera Prunus and Sorbus contains a number of species which are important components in various ecosystems found throughout North America (Shelford, 1963). Stressed native trees could be impacted (J).

The literature on CBT in Eurasia does not implicate this moth in environmental damage (G).

Controlling CBT in mature fruit orchards and various ornamental trees will contribute to an increase in insecticide use (G).

Estimate impact from social and/or political influences. LOW/MEDIUM (MC)

Loss of old ornamental or fruit cherry trees and/or the costs involved to protect them will undoubtedly impact private individuals. However, the overall impact will probably be low.

V. PEST RISK POTENTIAL RATING MEDIUM (RU)

VI. SPECIFIC QUESTIONS:

Should APHIS become involved in the eradication and/or quarantine of the Cherry Bark Tortrix ?

The CBT is well established in the Pacific Northwest. Eradication would be unlikely and extremely expensive if attempted (Bell, 1991) (LaGasa, 1991) (G).

Quarantine procedures will not be feasible unless a connection between the spread of the moth and man's activities can be established. At this time the spread of CBT appears to be confined to natural dispersal only.

Does biocontrol show promise in reducing the future negative impact of CBT ?

Unfortunately biocontrol shows little promise. Literature from Eurasia rarely mentions either predators or parasites as a factor influencing population levels of CBT. It is reasonable to believe that CBT in its native habitat does have its cadre of predators and

parasites but the protective larval environment is probably not one in which biocontrol is going to be effective (J).

One general predator that is recorded to feed on CBT larvae is Agulla xanthostigma . In the Soviet Union this Raphidiidae, in the larval stage, consumes significant quantities of CBT larvae (Boldyrev and Dobroserdov, 1981). Although, introducing a general predator like a foreign Agulla snakefly would not be acceptable, the western United States is unique because it has a relatively high number (at least 17 species) of native Agulla species (note - some taxonomists divide our western Agulla into two genera Raphidia and Alena) (Borror et al, 1981) (Arnett, 1985). Many, if not all, of our native Agulla species feed as larvae under bark on small insects including lepidoptera. It might be interesting to see if any of our native snakeflies show promise for biocontrol of the CBT.

VII. SUMMARY AND RECOMMENDATIONS:

Summary:

The Cherry Bark Tortrix is firmly established in Northwestern Washington and Southwestern British Columbia. A high concentration of mature cherry trees in the center of its range are infested.

Eradication is not feasible.

The Cherry Bark Tortrix is slowly spreading by natural dispersion among domestic mature cherry trees which are greatly stressed by other factors. The larvae feed in the bark and outer sapwood at the location of old and new wounds.

When CBT colonized North America, is speculative; but it was probably well established before its detection in either Canada or the United States. The CBT probably was introduced in, or adjacent to Vancouver, Canada.

CBT is not being spread by man's activities and therefore a quarantine is not justified at this time.

Biocontrol is unlikely because of the epidemiology of the pest. Chemical control is possible, but difficult and often ineffective.

Potential commercial and private damage to old orchards and ornamental host trees exists. Environmental damage to native Rosaceae trees and shrubs is unknown. Nursery stock does not appear to be susceptible to infestation at this time.

High uncertainty exists as to what level of damage CBT will cause if/when it spreads and evolves across the United States.

Recommendations:

1) No regulatory action is recommended at this time.

2) Provide incentive for research on the natural history of the CBT in North America to determine if future regulatory action will be necessary.

    a) Encourage a baseline study into the biology of the North American population of CBT to determine the size and density of the population, which host plants are at present being utilized, and the amount of damage that can be attributed to the moths.

    b) Monitor the North American CBT population, after the initial base line study has been completed. The function of the monitoring program would be to determine rate of spread, changes in host plant preferences, and the possibility of CBT entering a manmade pathway for dispersal (e.g. nursery stock).

3. Evaluate and test various treatments which could be used for regulatory control.

4. Further investigate biocontrol candidates.

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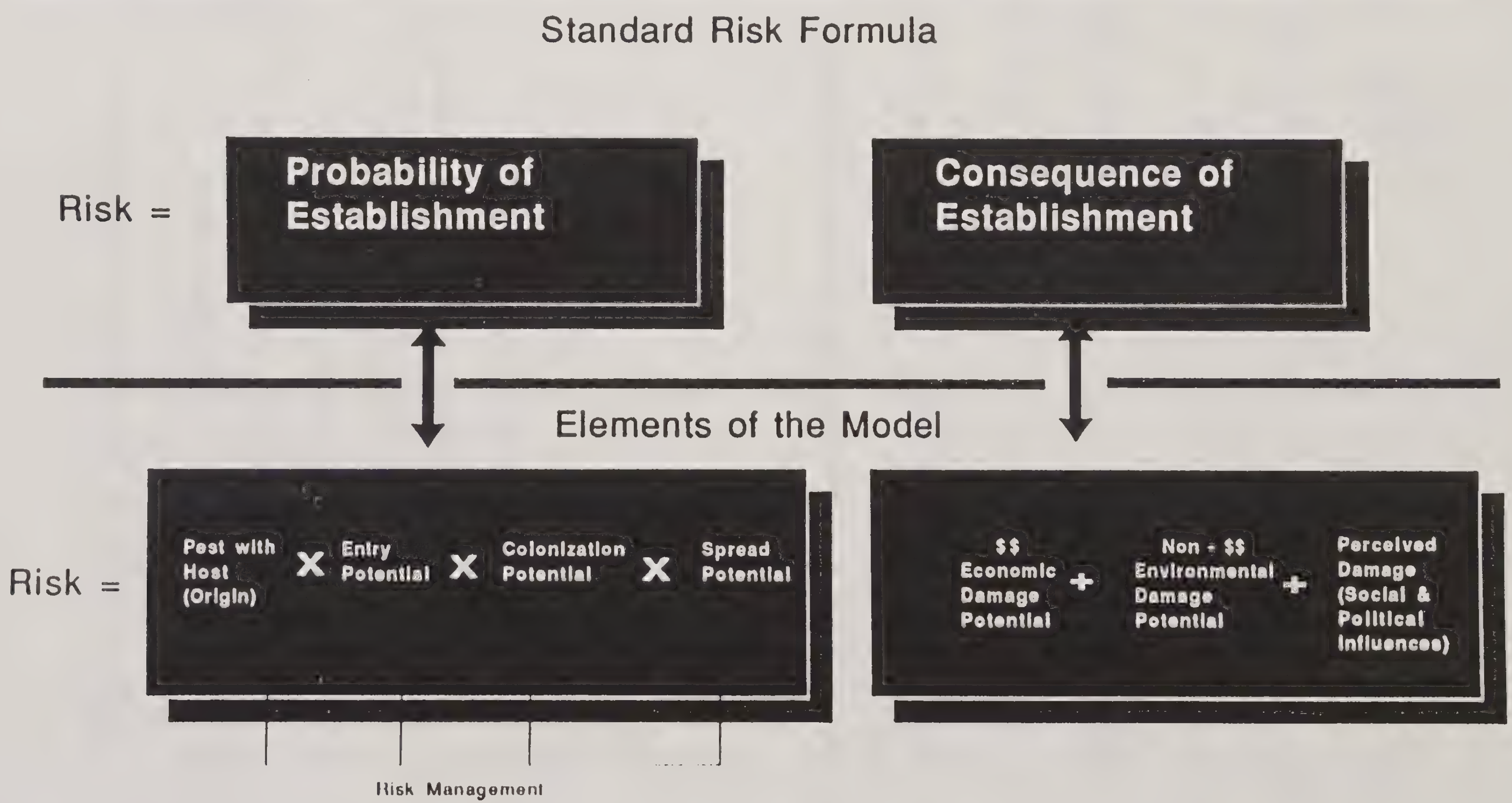
Pest Risk Assessment Model



- For model simplification the various elements are depicted as being independent of one another
- The order of the elements in the model does not necessarily reflect the order of calculation.

APPENDIX B: REFERENCE CODES TO ANSWERED QUESTIONS

Reference Code	Reference Type
(G)	General Knowledge, no specific source
(J)	Judgmental Evaluation
(E)	Extrapolation; information specific to pest not available; however information available on similar organisms applied
(Author, Year)	Literature Cited

APPENDIX C: UNCERTAINTY CODES TO INDIVIDUAL ELEMENTS

Uncertainty Code	Symbol	Description
Very Certain	VC	As certain as I am going to get
Reasonably Certain	RC	Reasonably certain
Moderately Certain	MC	More certain than not
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess, little or no evidence of the real value

APPENDIX IV: Mitigation Matrix

The following mitigation matrix (USDA, APHIS, 1991)was created to identify the mitigation measures that could be used to reduce the pest risk resulting from the importation of larch from Russia (USDA, FS, 1991).

Summary Table—Mitigation measures available for pests and pathogens associated with larch timber from the Soviet Union

	MB	SF	PH	KD	SH	IR	DB
Pests on the outer surface							
Asian gypsy moth (*Lymantria dispar*) Nun moth (*Lymantria monacha*)	E	N	E	E	E	R	E
Root/stump insects (Scolytidae, Curculionidae) *Hylastes, Hylurgus, Hylobius, Hylurgops*	E	E	E	E	E	E	E
Scale insects (*Physokermes, Aspidiotus, Lepidosaphes, Nuculaspis, Matsucoccus*)	E	E	E	E	E	R	E
Flatbugs (*Aradus cinnamomeus*)	E	E	E	E	E	R	E
Aphids (*Cinara sp.*) Wooly adelgids (*Adelges* spp.) Siberian silk moth (*Dendrolimus sibericus*)	E	E	E	E	E	R	E
Pathogens Melampsora rust (*Melampsora sp.*) Larch needle cast (*Meria laricis*) Conifer shoot blight (*Sirococcus strobilinus*)	R	N	N	E	E	R	E
Pests in or under the bark							
Engraver beetles (*Ips duplicatus, I. sexdentatus, I. subelongatus, I. typographus, Dendroctonus micans*) Weevils (*Pissodes* spp.)	E	E	E	E	E	R	E
Pests in the wood							
Monochamus urussovi, Xylotrechus altaicus	E	E	E	E	E	N	N
Siricidae (*Paururus, Xeris, Sirex*)	E	E	E	E	E	N	N
Pathogens Larch canker (*Lachnellula willcommii*) Annosus root rot (*Heterobasidion annosum*) Staining/vascular diseases (*Ophiostoma sp.*) Red ring rot (*Phellinus sp.*) *Leptographium spp.*	R	R	R	E	E	N	N
Wood nematodes (*Bursaphelenchus kolymensis, B. mucronatus*)	R	R	E	E	E	N	N

Abbreviations:
MB — Methyl bromide fumigation
SF — Sulfuryl fluoride fumigation
PH — Phosphine fumigation
***KD** — Kiln drying
SH — Steam heat or hot water dip
IR — Irradiation
DB — Debarking

E — Effective
N — Not effective
R — Requires research

***Note on kiln drying:** This treatment would be applicable to squared and cut lumber but not whole logs.